

1368

A STUDY OF SOME POSSIBLE USES OF PURE MAPLE SYRUP AND ITS PRODUCTS IN ICE CREAM¹

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Mr. McDermott was born in New York City on April 2, 1930. He attended elementary and high schools in New York City and completed the two year course of study at the New York State Agricultural and Technical Institute at Delhi, New York. From January 1951 until December 1953, he served as a medical technician and food inspector with the Veterinary Corps of the United States Air Force. While in the Air Force, he received a four month course in food inspection and environmental sanitation at Colorado A&M College. Upon completion of his active tour of military duty, he attended Hunter College of the City of New York for one and a half years and then transferred to the College of Agriculture at Cornell University, where he was a student of Dairy Science. He received the Dairy Marketing Research Fund Award in his senior year and received the Bachelor of Science degree in June 1957. During the same year, he entered the Graduate School of Cornell University as a candidate for the degree of Master of Science, with a major in Dairy Science and a minor in Business Management and Administration. While working for his advanced degree, he held a research and teaching assistantship in the Department of Dairy Industry. He was granted the Master of Science degree in June 1959.

SEARCHING BACK THROUGH THE REPORTS and writings on the making of ice cream and flavors used in ice cream, there is indeed several references to the making of ice cream flavored with pure maple syrup or maple sugar.

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The literature states how much maple syrup or maple sugar to add to an ice cream for a pleasing flavor of maple, however, no mention is made of the specific grade of maple to be used. In the light of current advances in knowledge, technology, processing procedures, and established standards of grading maple products, it would appear desirable and important to know more precisely what grade or grades of maple syrup can be used, and how much is required to meet the acceptability of current consumer flavor standards. Putting it another way, we might say how different is ice cream and maple syrup today as compared to the products of several years past?

A considerable amount of information was obtained in more recent years concerning maple syrup and the development of maple flavor during the processing of maple sap to a syrup. As a result of work done at the USDA Regional Research Laboratory in Philadelphia by Drs. Porter, Willits, Underwood and other staff members, the U. S. Department of Agriculture obtained a public patent which relates to a high heat treating process of maple saps and syrups to intensify the flavor of maple beyond that which could previously be obtained and controlled.

It had generally been known by ice cream makers that considerably large quantities of maple syrup would be required to add to an ice cream mix before a sufficiently strong flavor of maple would be produced. This necessity of large quantities of maple syrup, to impart a maple flavor to ice cream, would consequently increase the water and sugar content of the ice cream and therefore dilute the dairy ingredients of the ice cream, resulting in a product which was soft and weak in body, had a lower freezing point, was too sweet, and did not meet the minimum legal requirements of composition for ice cream. The cost to flavor a gallon of ice cream was also a prohibiting factor. Some of the disadvantages could be avoided by designing a special ice cream mix formulation to accommodate the large quantities of water and sugar added in the form of maple syrup, but this special mix could then only be used to produce a maple ice cream.

It is more preferred from the production viewpoint to make one stock ice cream mix which can meet the variety of flavor demands, unless there is a sufficient volume of a particular flavor to warrant processing a special ice cream mix, such as the case of chocolate ice cream. With the development of a maple syrup which had more intense flavor, it might be possible to flavor ice cream with natural flavor instead of artificial maple flavors without having to make a special ice cream mix. This had yet to be ascertained and because of interest in the work, the USDA Regional Research Laboratory in Philadelphia sponsored a study of the problem which was conducted by the Cornell University Department of Dairy Industry in Ithaca.

The study included the grade or grades of maple syrup that could be used, the quantity required to give an optimum flavor of maple in the finished product, and in what processed forms the maple syrup could be used. The

procedure followed was to test the four recognized grades or mixtures of grades of maple syrup, each at the same concentration in the various forms possible in an ice cream. Relationships between the grade of the maple syrup used and the strength and character of the flavor in the finished products ruled out the use of a particular grade or indicated the necessity to make modifications for each of the grades if they were to be used. A laboratory panel of ten expert food tasters was utilized to screen preliminary samples and aid in the selection of the grade of maple syrup that would be used for a particular treatment, and to establish that there was a recognizable variation within a treatment which was within a range of general consumer acceptability. The application of basic economics was also used to aid in the selection of a grade of maple syrup. For example, if a lower grade of maple syrup was found as acceptable as a higher grade of syrup, or comparable results could be obtained by using less of a lower grade syrup, then that particular grade of maple syrup was selected to flavor ice cream samples for presentation to consumers for evaluation.

Each grade of maple syrup was added to a modified formula ice cream mix at a rate of 20 per cent maple syrup by weight of the finished ice cream mix. The ice cream mix was so calculated that the addition of maple syrup and a 67 per cent sucrose solution would dilute the ingredients of the basic mix so the final mix before freezing had a balanced composition of 12 per cent butterfat, 10.5 per cent milk solids not fat, 16.75 per cent sugar (expressed as sucrose), 0.4 per cent stabilizer and 0.05 per cent emulsifier. Each ice cream was frozen to 80 per cent overrun, which is about an average for the industry, and considered to produce a good ice cream. The samples were kept at -10°F . until tested.

Laboratory panel members, who had been selected from the staff of the Departments of Dairy Industry and the College of Home Economics at Cornell, were presented with the four samples of ice cream that had been flavored with the various grades of maple syrup. The temperature of the ice creams at the time of sampling was considered to be about $+20^{\circ}\text{F}$ and an attempt was made throughout the study to temper all samples of ice cream to this temperature just prior to tasting by taste panel members. Most of the laboratory panel members found the ice cream flavored with the High-Flavored, U. S. Grade B maple syrup to present the most satisfying and characteristic flavor of maple in the ice cream at the 20 per cent level. The ice cream with the lowest grade or unclassified grade of maple syrup was objected to because of the caramelized and uncharacteristic flavor of maple. The other two grades of maple syrup in ice cream were found pleasant but lacking in strength of flavor. The mildness of flavor for the highest two grades of maple syrup is characteristic for those grades and it was found that a flavor comparable to that obtained in the ice cream containing High-Flavored, U.S. Grade B maple

syrup could be obtained if approximately two to four per cent more of the higher grades of maple syrup were used in the ice cream.

Ice creams were also made which contained the lowest two grades of maple syrup that had not received the high heat flavor intensification processing but it was found that upwards of 25 per cent by weight of these maple syrups had to be added to the ice cream mix if sufficient flavor was to be achieved. The ice cream with the lowest grade of maple syrup was again ruled out as having a caramelized and uncharacteristic flavor of maple. It was clearly visible that high-flavoring of maple syrup did lower the requirement of the quantity of maple syrup needed to flavor an ice cream. It was further observed that the lowest grade of maple syrup could not successfully flavor an ice cream and the higher the grade of the maple syrup, the greater the quantity of maple syrup would be required to impart sufficient flavor.

The High-Flavored, U. S. Grade B maple syrup was incorporated in an ice cream at three different levels, 15, 20, and 25 per cent by weight of maple syrup in the finished ice cream. With the assistance of the laboratory taste panel, it was deemed that these levels were within the general range of acceptability of consumers and the difference in the levels of maple syrup used was sufficient to be perceptible.

Consumers were presented with two of the three ice cream samples and were asked to try them and give answers to certain questions asked by the interviewer. The ice creams the consumers tried were paired either low vs. medium concentration of maple; medium vs. high concentration of maple, or low vs. high concentration of maple. The consumers were asked to freely offer comments on the ice cream, indicate which sample they preferred if they had a preference, and rate how well they liked each sample by referring to a nine-point hedonic scale. The hedonic scale translated on a uniform communicative level the degree of appeal that each sample presented to the consumer making the comparison, and this in turn was assigned a numerical value that could be tabulated. Depending upon how well a sample was liked, it could be rated +1 to +4 and disliking a sample would give it a rating of -1 to -4, with a zero rating assigned to a sample if it did not qualify as being definitely liked or disliked.

The results of testing ice creams which contained a standard Grade B maple syrup, or maple syrup as it would be purchased at the farm, showed that 25 per cent by weight of maple syrup was most preferred when the concentrations of maple in ice cream were 15, 20, and 25 per cent. The same preference was shown for an ice cream which contained High-Flavored, U. S. Grade B maple syrup, that is at the 25 per cent concentration of maple syrup, but consumers found the flavor to be more pronounced and definite, a characteristic which was more generally preferred.

A reveal material was made from the maple syrups and tried in ice cream. In order to streak the maple syrup through ice cream to give the ice cream

a marbelized appearance, a way had to be devised to increase the viscosity of the maple syrup and prevent ice crystals and subsequent sugar crystals from forming in the revel when kept at ice cream storage temperatures of -10°F . A satisfactory effect was achieved by warming up maple syrup to about 160° to 170°F . and dissolving cellulose gum (CMC, type 7H) and corn syrup solids in the syrup at the rate of 12 gms of CMC and 4 gms of corn syrup solids per volumetric quart of maple syrup. The maple syrup revel, when chilled to 40°F . could be variegated or streaked through ice cream as it came from the freezer and subsequent hardening of the ice cream did not cause unsatisfactory physical changes to develop in the revel or ice cream.

Revels were made from each of the four grades of high-flavored maple syrup as well as from the two lower grades of maple syrup which had not received the high heat, flavor intensification processing. Samples of the various grades of maple syrup revel in ice cream were made all at the same revel concentration in an ice cream which had been flavored with one half of the normal amount of vanilla. The samples were screened by the laboratory panel and it was found that the lowest grade of standard maple syrup produced a revel which was too harsh and caramelized in flavor, and the lowest two grades of high-flavored maple syrup revel were eliminated for this same reason. A maple syrup revel material for ice cream could thus be made from a standard U. S. Grade B maple syrup, or if high-flavored maple syrup was used, the indication was that the next higher grade, or a U. S. Grade A maple syrup was required. The character and intensity of the maple flavor could be compensated for in the revel material by selection of the appropriate grade of maple syrup.

An attempt was made to add the revels to an ice cream at three different rates, 10 per cent, 15 per cent, and 20 per cent revel material by weight of the finished product. Consumers were presented with two samples of ice cream and the testing procedure was as indicated previously. The ice cream which contained High-Flavored, U. S. Grade A maple syrup revel at the 20 per cent concentration was the most preferred and where a standard U. S. Grade B maple syrup revel was incorporated in an ice cream, the concentration preferred was about 28 per cent maple syrup revel in the ice cream.

It may be pointed out at this time that high-flavoring of the maple syrup reduced the quantity of maple syrup revel needed to present a strong and positive flavor effect in the ice cream. It may be noted also that a higher grade of syrup, which normally has a milder flavor, could be used for the revel material and the character of the flavor was more that of maple and less of the caramelized and burnt sugars.

To reduce the contrast between a relatively unflavored ice cream and a pronounced maple flavored revel, maple syrup revel was incorporated into a maple flavored ice cream to study if a background flavor of maple enhanced the flavor of the maple syrup-revel. The maple ice cream was made from a

modified formula mix as previously described. One ice cream mix contained 10 per cent maple syrup by weight, while another contained 20 per cent maple syrup. High-Flavored U. S. Grade B maple syrup was used in each ice cream and the sugar content of each ice cream, expressed as sucrose, was made equal by regulating the quantity of 67 per cent sucrose solution added to each mix.

The maple flavored ice cream mixes were each frozen to 80 per cent overrun in a continuous freezer and High-Flavored, U. S. Grade A maple syrup-revel was injected into each ice cream so the finished ice creams contained 15 per cent by weight of maple syrup revel. The one finished ice cream had a higher total maple content and less flavor contrast between the revel and the ice cream, while the other had less total maple content and slightly more flavor contrast between the revel and the ice cream.

Consumers indicated a greater preference for the ice cream which contained less total maple or the ice cream which contained 10 per cent maple syrup in the background ice cream and 15 per cent maple syrup revel. Almost identical results were obtained when similar ice creams were compared in which a standard U. S. Grade B maple syrup was used to flavor the background ice cream and standard U. S. Grade B maple syrup was used for the revel material. Like the ice creams which contained the high-flavored maple syrups, the one ice cream had 10 per cent by weight of maple syrup in the flavored mix, and the other had 20 per cent maple syrup by weight in the flavored mix. When each was frozen to 80 per cent overrun, 16 per cent of maple syrup-revel by weight of finished ice cream was injected into each ice cream.

Although it appeared that consumers more favorably accepted the revel ice cream with a background ice cream flavored with maple, as opposed to either a plain maple flavored ice cream or a maple syrup revel in an unflavored ice cream, there is no overwhelming evidence that this would prove the most successful formulation in any given area or market.

A maple confection for incorporation in ice cream was made from each of the four grades of high-flavored maple syrup. The confections were made by boiling the maple syrup in a steam jacketed kettle until a boiling point of about 265°F. was attained. The highest grade, or U. S. AA maple syrup seeded itself when the sugar solution became highly concentrated but due to invert sugars in the lower three grades of maple syrup, the concentrated syrup had to be cooled quickly to about 200°F. and seeded with confectionery sugar to promote the desired crystal formation. The moist crystalline sugar was pressed through a screen with $\frac{1}{4}$ inch round holes and upon cooling and drying, the confections were broken up and screened to remove the finer particles and those pieces which were larger than about the size of a garden pea.

Each of the confections made from the four grades of high-flavored maple syrup were added to an ice cream which had been flavored with one half the normal amount of vanilla. The confections were added at a rate of $\frac{1}{2}$ pound of candy per gallon of ice cream mix and the confections were distributed

throughout the ice cream immediately after it was drawn from a continuous freezer at 80 per cent overrun. The laboratory taste panel pre-tested the ice creams and the ice cream which contained the confections made from the high-flavored, U. S. Grade B maple syrup was selected for presentation to the consumers.

Three different samples for consumer testing were made using the High-Flavored, U. S. Grade B maple confection at three levels; $\frac{1}{2}$ pound confection per gallon of ice cream mix; $\frac{3}{4}$ pound confection per gallon of ice cream mix, and one pound of confection per gallon of ice cream. In each case, the confection was added to a 12 per cent fat ice cream which had been flavored with one-half the normal amount of vanilla and frozen to 80 per cent overrun in a continuous freezer.

The consumers were presented with two $2\frac{1}{2}$ ounce samples of the ice creams, either low and medium, medium and high, or low and high concentrations of confection in the ice cream. As a result of testing the ice creams, it appeared that $\frac{3}{4}$ pound of the maple confection per gallon of ice cream mix was the level most preferred by the consumers. The tendency was toward a greater quantity of candy in the ice cream rather than a smaller quantity shown by the second greatest preference for the ice cream which contained one pound of confection per gallon of mix.

A comparison was also made of maple flavored ice creams which contained maple confections. The maple flavored ice creams were made from a modified formula ice cream mix and one mix contained 10 per cent High-Flavored, U. S. Grade B maple syrup by weight, while the other contained 15 per cent maple syrup by weight. The sugar content of each mix was 15 per cent and was made equal by adjusting the quantity of 67 per cent sucrose solution added to the mixes. The flavored mixes were frozen to 80 per cent overrun in a continuous freezer and High-Flavored, U. S. Grade B maple confection was added to the 10 per cent maple flavored mix at a rate of $\frac{3}{4}$ pound of confection per gallon of flavored mix while the ice cream which contained 15 per cent maple syrup received the maple confections at the rate of $\frac{1}{2}$ pounds per gallon of mix.

The results of the comparison of these two ice creams by consumers showed almost an equal preference for both ice creams and two groups or 27 per cent of the consumers said they would consider buying one or the other of the ice creams if it were offered for sale at some time in the future. Another 9 per cent of the consumers said they would buy either of the ice creams no matter which formula was used in potential production.

A high density maple topping for ice cream was studied and evaluated and the pattern followed was much the same as used throughout the study. The laboratory taste panel pre-tested toppings all at the same density but made from the different grades or mixtures of grades of maple syrup. The lowest cost topping, according to the grade which was found acceptable in

flavor by the laboratory panel, was made to three different densities and presented to the consumers on a scoop of vanilla ice cream for their comments.

The toppings were made by boiling the maple syrups in a steam-jacketed kettle to approximately 15°F. above the boiling point of water. The concentrated syrups were then allowed to cool slowly to about 131°F. and Convertit, an invertase enzyme, was added to the concentrated syrups at a rate of 3 ml of Convertit per 200 gms of the concentrated syrup. Holding the inoculated syrups for 16 to 18 hours at this optimum temperature for enzyme activity allowed for inversion of about 50 per cent of the sucrose present in the solution. This inversion process produced invert sugars which are more soluble and reduced the tendency of sugar crystals to form in the super-saturated solution. The density of the toppings at this point was about 80° Brix and portions of the toppings were adjusted to various densities by the addition of distilled water.

The topping selected by the laboratory panel for presentation to consumers was a mixture of equal parts of High-Flavored U. S. Grade AA, A, and B and the densities chosen were 72° Brix, 75° Brix and 78° Brix. The viscosities for the toppings were 620, 1250, and 3300 centipoise for the 72°, 75° and 78° Brix toppings respectively. Presentation to consumers in pairs of the three possible combinations resulted in no conclusive evidence that any specific density or viscosity of the topping was most preferred.

Similar toppings made from U. S. Grade B and U. S. Unclassified maple syrup which had not been high-flavored showed a slight preference for the topping which had a density of 72° Brix.

Since this study was quite extensive and much of the information obtained could better be clarified with lengthy discussion, time does not allow me to go into some of the finer details nor present my personal views on the problem, the course of the investigation, or the results. I have presented some of the high-lights of the study. In closing, I will say that it is possible to make good high quality ice cream with some pure maple products included which will meet consumer acceptance. Several variations have been offered and differences of departure from the suggested grades, concentrations, or processes may be indicated for individual markets or as knowledge is gained and technology advances in the particular area of producing and processing of maple syrup and ice cream.